Lithium iron Phosphate Battery

Specification Approval Sheet

Model	MC-12Li18
Nominal voltage	12.8V
Date	05.07.2014

Content

1. Scope

This document describes the Product Specification of the Lithium-iron rechargeable battery module supplied by Master Battery.

2. Model: MC-12Li18

3. Specification

No.	Items	Specifications
1	Charge cut-off voltage	14.6V
2	Nominal voltage	12.8V
3	Minimal capacity (1C)	18Ah @ 0.5C Discharge
4	Nominal capacity (1C)	18.5Ah @ 0.2C Discharge
5	Nominal Charge current	0.2C
6	Standard charging method	CC@0.2C (constant current) charge to 14.6V, then CV (constant voltage 14.6V) charge till charge current decline to ≤ 0.05C
7	Charging time	Standard charge: 5.5 hours Ref
8	Max. charge current	0.5C (0.2C RECOMMENDED)
9	Max. continue discharge current	25A @ 23° C (Cell skin temperature cannot exceed 60°C)
10	Peak current rate	60-70A for 1-2S
11	Discharge cut-off voltage	10.0V
12	Operating temperature	Charging: 0°C ~ 45°C Discharging: -20°C ~ 60°C (Cell skin temperature cannot exceed 60°C)
13	Storage temperature/ humidity	Temperature -30°C ~ +50°C Humidity 75% ± 20%RH (Recommended to store 23 ± 5°C for long term storage)
14	Battery Weight	2.2 kg
15	Battery Dimension	168 mm x 128 mm x 75 mm

4. Battery Module Performance Criteria

4.1. Electrical characteristics

<table>
<tr><th>No.</th><th>Items</th><th colspan="4">Test Method and Condition</th><th>Criteria</th></tr>
<tr><td>1</td><td>Standard Charge</td><td colspan="4">Charging the battery initially with constant current at 0.5C and then with constant voltage at 14.6V till charge current declines to 0.05C.</td><td>N.A.</td></tr>
<tr><td>2</td><td>Rated Cap 1C</td><td colspan="4">Capacity measured with discharge current of 1C with 10.0V cut-off voltage after the standard charge.</td><td>≥18Ah</td></tr>
<tr><td>3</td><td>Cycle Life</td><td colspan="4">Test condition：
Temperature: 23 ± 5°C
Charge: CC@0.2C to 14.6V, and CV to 0.05C cut off
Discharge: 0.2C discharge to10.0V.
Remain 80% or more of the initial capacity of the cells at 0.2C discharge of operation</td><td>≥ 2000 times</td></tr>
<tr><td rowspan="4">4</td><td rowspan="4">Storage Performance</td><td colspan="4">Battery module stored at 25°C with 50% SOC</td></tr>
<tr><td></td><td colspan="2">1Month</td><td>3Month</td><td>6Month</td></tr>
<tr><td>Cap Retention</td><td colspan="2">98%</td><td>96%</td><td>94%</td></tr>
<tr><td>Cap Recovery</td><td colspan="2">99%</td><td>97%</td><td>95%</td></tr>
<tr><td>5</td><td>Initial Impedance</td><td colspan="4">Internal resistance measured at AC 1KHz after 50% charge</td><td>≤ 120mΩ</td></tr>
<tr><td>6</td><td>Battery Voltage</td><td colspan="4">As of shipment</td><td>13.2~13.6V</td></tr>
</table>

4.2. Visual inspection

There shall be no such defect as scratch, flaw, crack, and leakage, which may adversely affect commercial value of the battery.

4.3. Standard environmental test condition

Unless otherwise specified, all tests stated in this Product Specification are conducted at below condition:

Temperature: 23 ± 5°C

Humidity: 75 ± 20% RH

5. Storage and Others

5.1. Long Time Storage

If the battery is stored for a long time, the battery's storage voltage should be 12.8~13.6V and the battery is to be stored in a condition as No. 4.4.

5.2. Others

Any matters that this specification does not cover should be conferred between the customer and Master Battery.

6. Cell and Assembly Method

MC-26650E- in 4S6P to reach 12.8V18Ah

Handling Precautions and Guideline For LiFePO4 Rechargeable Batteries

Preface This document of "Handling Precautions and Guideline" shall be applied to the battery manufactured by Master Battery.

Note (1) The customer is requested to contact Master Battery in advance, if and when the customer needs other applications or operating conditions than those described in this document. Additional experimentation may be required to verify performance and safety under such conditions.

Note (2) Master Battery will take no responsibility for any accident when the battery is used under other conditions than those described in this document.

Note (3) Master Battery will inform, in a written form, the customer of improvement(s) regarding proper use and handling of the battery if it is necessary.

1. Charging

1.1. Charging current

Charging current should be less than the maximum charge current specified in the Product Specification. Charging with higher current than recommended value may cause damage to cell electrical, mechanical and safety performance and could lead to heat generation or leakage.

1.2. Charging voltage

Charging shall be done by voltage less than that specified in the Product Specification (3.65V/cell). Charging beyond 3.70V, which is the absolute maximum voltage, must be strictly prohibited. The charger shall be designed to comply with this condition. Charging with higher voltage than maximum voltage may cause damage to the cell electrical, mechanical safety performance and could lead to heat generation or leakage.

1.3. Charging temperature

The battery shall be charged within -10°C~45°C range in the Product Specification.

1.4. Prohibition of reverse charging

Reverse charging is prohibited. The battery shall be connected correctly. The polarity has to be confirmed before wiring. In case of the battery is connected improperly, the battery cannot be charged. Reverse charging may cause damage to the battery which may lead to degradation of battery performance and damage the battery, which will cause heat generation or leakage.

2. Discharging

2.1. Discharging current

The battery shall be discharged at less than the maximum discharge current specified in the Product Specification. High discharging current may reduce the discharging capacity significantly or cause over-heat.

2.2. Discharging temperature

The battery shall be discharged within -20°C ~ 50°C range specified in the Product Specification.

2.3. Over-discharging

It should be noted that the battery would be at an over-discharged state by its self-discharge characteristics in case the battery is not used for long time. In order to prevent over-discharging, the battery shall be charged.

Periodically to maintain between 12.8V and 13.6V. Over-discharging may causes loss of battery performance, characteristics, or battery functions. The charger shall be equipped with a device to prevent further discharging exceeding a cut-off voltage specified in the Product Specification.

Also the charger shall be equipped with a device to control the recharging procedures as follows:

The cell/battery pack shall start with a low current (0.01C) for 15 - 30 minutes, i.e. pre-charging, before rapid charging starts. The rapid charging shall be started after the (individual) battery voltage has been reached above 12V within 15 - 30 minutes that can be determined with the use of an appropriate timer for pre-charging. In case the (individual) cell voltage does not rise to 3V within the pre-charging time, then the charger shall have functions to stop further charging and display the cell/pack is at abnormal state.

3. Protection Circuit Module (PCM)

The cell/battery pack shall be with a PCM that can protect cell/battery pack properly. PCM shall have functions of (1) overcharging prevention, (2) over-discharging prevention, and (3) over current prevention to maintain safety and prevent significant deterioration of cell performance. The over current can occur by external short circuit.

3.1. Overcharging prohibition

Overcharging prevention function shall stop charging if any one of the cells of the battery pack reaches 3.8V.

3.2. Over-discharge prohibition

Over-discharging prevention function shall work to avoid further drop in cell voltage of 2.5V or less per cell in any cell of the battery pack. It is recommended that the dissipation current of PCM shall be minimized to 0.5mA or less with the over-discharge prevention.

The protection function shall monitor each bank of the battery pack and control the current all the time.

4. Storage

The battery shall be storied within -40°C ~ 50°C range environmental conditions. If the battery has to be stored for a long time (Over 3 months), the environmental condition should be:

Temperature: 23 ± 5°C

Humidity: 75 ± 20% RH

The voltage for a long time storage shall be 13.2V~13.6V range.

5. Others

5.1. Prevention of short circuit within a battery pack

Enough insulation layers between wiring and the cells shall be used to maintain extra safety protection. The battery pack shall be structured with no short circuit within the battery pack, which may cause generation of smoke or firing.

5.2. Prohibition of disassembly

5.2.1. Never disassemble the battery

The disassembling may generate internal short circuit in the battery, which may cause gassing, firing, or other problems.

5.2.2. Electrolyte is harmful

LIP battery should not have liquid from electrolyte flowing, but in case the electrolyte come into contact with the skin, or eyes, physicians shall flush the electrolyte immediately with fresh water and medical advice is to be sought.

5.3. Prohibition of dumping of battery into fire

Never incinerate nor dispose the battery in fire. These may cause firing of the battery, which is very dangerous and is prohibited.

5.4. Prohibition of battery immersion into liquid such as water

The battery shall never be soaked with liquids such as water, seawater, and drinks such as soft drinks, juices, coffee or others.

5.5. Battery replacement

The battery replacement shall be done only by either battery supplier or device supplier and never be done by the user.

5.6. Prohibition of use of damaged battery

The battery might be damaged during shipping by shock. If any abnormal features of the cells are found such as damages in a plastic envelop of the battery, deformation of the battery package, smelling of an electrolyte, an electrolyte leakage and others, the battery shall never be used any more.

The battery with a smell of the electrolyte or a leakage shall be placed away from fire to avoid firing.